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**STORM WATER POLLUTION PATROL: A THEMATIC UNIT
FOR USE IN ELEMENTARY CLASSROOMS**

**A Project
Presented to the
Faculty of
California State University,
San Bernardino**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education: Environmental Option**

**by
Linda Ann Sánchez
June 1996**


STORM WATER POLLUTION PATROL: A THEMATIC UNIT
FOR USE IN ELEMENTARY CLASSROOMS

A Project
Presented to the
Faculty of
California State University,
San Bernardino

by
Linda A. Sanchez

June 1996

Approved by:


Darleen Stoner, Ph.D, First Reader

June 14, 1996
Date


Denise Price, M.A., Second Reader

ABSTRACT

This thematic unit is designed to develop an awareness and knowledge of storm water pollution by elementary students. A teacher's guide with supplementary student activities was developed to support the use of a student booklet on storm water. Areas of focus include learning about the various aspects of storm water, taking action to prevent storm water pollution, and promoting water quality. The unit takes approximately two to three weeks to complete.

The unit contains reading sections for information and corresponding activities to assist and enhance the learning of students at different grade levels. An interdisciplinary approach is utilized with the following curricular areas: language arts, social studies, science, math and art. Cooperative grouping and experiential, or hands-on, learning methods are also employed.

ACKNOWLEDGEMENTS

I would like to thank my husband, Jorge, for his patience, understanding, and for encouragement throughout this entire project. I thank my daughter, Taylor Autumn, for her hugs and smiles.

I would also like to thank Dr. Darleen Stoner and Denise Price for their advice and guidance.

"BIG"

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INTRODUCTION

Our Earth is at risk of being destroyed by the very inhabitants that call it home. As the story The Giving Tree by Shel Silverstein hints, people take and take from nature but very rarely, if at all, return anything. Weintraub stated that “humans are both the primary beneficiaries and the eventually harmed parties of human exploitation of the Earth” (1995, p. 342). We mine, extract, pollute, and exploit natural resources for short term benefits without regard to long-term outcomes. Through environmental education, we can learn how to protect and preserve the Earth from our misuse and contamination. Awareness of planetary needs, including clean water, is essential for the quality of life for future generations.

Environmental education, in one form or another, should be utilized in the classroom every day. Persons who practice positive environmental behaviors often credit early exposure to a natural, pristine environment as their source of inspiration. Education about the environment comes in different forms. The best of these is experiential. But because many school children, particularly those living in the urban areas, are not directly exposed to the natural environment, environmental education within the classroom must become the main source of enlightenment.

Water quality protection was the main focus of this master’s project. This program was developed based on the belief that if students at an early age become aware of the harmful consequences of storm water pollution, they will act to protect and preserve water and waterways. Water and the surrounding wildlife are being contaminated or harmed by soap, oil, anti-freeze, pesticides, and other pollutants that get into storm drains.

Curriculum about storm water pollution has been very limited. Because storm water pollution can occur in both urban and rural areas, this curriculum fills a local environmental need. Storm water pollution is a local issue by which awareness,

knowledge, and actions can make a difference.

The Storm Water Pollution Patrol unit provides hands-on lessons to help students understand the importance of clean water. Focusing on grades K-6, students compose solutions for maintaining clean run-off that flows into the storm drain pipes. Students are exposed to the complex web interrelating people's actions and the environment. Students can experience success as they identify, analyze, research, and act to protect storm water and waterways.

REVIEW OF THE LITERATURE

The literature establishes a need for active environmental education. Active environmental education involves people who practice positive environmental behaviors. After defining environmental education, the literature reviews obstacles to environmental education faced by students, educators, and society. Approaches to overcome the obstacles include learning and teaching strategies based on constructivism, interdisciplinary and thematic teaching, cooperative grouping, and experiential learning.

Defining Environmental Education

Stapp defined environmental education as “aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve those problems, and motivated to work towards their solution” (Stapp et al., 1969, p. 31). The Tbsili Declaration of 1977 defined environmental education as a multifaceted curricula which includes awareness, knowledge, attitude, skills, and participation aimed at responsible environmental behavior (Ramsey, Hungerford, & Volk, 1992). As part of this declaration, teachers were challenged to the following: create a society that is sensitive to environmental problems; motivate citizens to participate in protecting and improving the environment; and lastly, identify environmental problems and work together in resolving them (Hungerford & Volk, 1990).

To many people, the foremost goal of environmental education is to produce educated citizens who not only possess knowledge but act responsibly toward each other and the environment (Ramsey & Hungerford, 1989). The protection of the environment for “present and future generations” is crucial to environmental education (Ramsey et al., 1992, p. 35).

Environmental education is based on science concepts. The California State

Department of Education states that the goals of environmental education should include awareness and knowledge of the biophysical environment, the “interdependenc(y) of all life”, and environmental problem solving (Science and Environmental Education Resource Guide 1990-91). These goals inherently incorporate the utilization of scientific knowledge and methods. Ballard and Pandya specified three components of a complete environmental education curriculum: natural systems, resources, and human resources (1990). Topics include biotic and abiotic elements interacting as systems and with the environment as a whole. Science concepts are an integral part in curricula and programs concerning environmental education.

Thirty four environmental education studies were reviewed by Leeming, Dwyer, Porter, and Cobern to “evaluat(e) the effects of a manipulated independent variable intended primarily to alter environmentally relevant knowledge, attitudes, or behaviors” (1993, p. 9). These variables included instruction, activities, simulations, case studies, values clarification, manuals, and curriculum. The findings indicated a wide range of effectiveness when measuring knowledge, attitude, and behavior. After reviewing the results, these researchers (1993) suggested that programs which alter behavior are critical for environmental education. Even so, only five of the studies measured behavior as an outcome; all the others measured attitude or knowledge. They concluded that positive environmental behavior needs to be further analyzed and emphasized. As noted by Leeming et al., “Although changes in knowledge or attitudes are important,...changes in behavior will ultimately affect the quality of our environment” (1993, p. 20).

Obstacles to Environmental Education

Obstacles to environmental education include: a) many states lack requirements for an environmental education component in schools, b) instruction which is not continuous or complete, c) low environmental knowledge of students and teachers,

and d) implementation barriers. Recognizing and understanding these obstacles will aid in the development and operation of effective environmental education courses or programs (Samuel, 1993).

Concerning these obstacles, Hausbeck et al. (1992) found that New York, like most other states, does not require environmental education courses at either the elementary or the secondary level. Environmental content is voluntarily integrated into the curriculum at the discretion of the administrators or, most likely, the teachers. Consequently, environmental education in the United States is not a complete, continuous instructional program.

During their study, Hausbeck, Milbrath, and Enright assessed the environmental knowledge, awareness, and concern of 11th-grade students in New York. They found that 11th-grade students possessed relatively high awareness and concern for the environment, but their knowledge was low (1992). Knowledge scores were based on "factual ideas" concerning the environment. Although individual scores varied greatly due to factors such as public vs. private school and urban vs. rural locations, knowledge was consistently lower than awareness. Another study found that it was not only students who possess little knowledge of the environment but teachers as well (Samuel, 1993). Like their students, teachers possessed a high awareness of various environmental issues but they had limited knowledge of the related scientific concepts.

The discrepancy between high levels of awareness and concern, but a low level of knowledge, might be due to "electronic media," especially television. Environmental issues have been increasingly exposed and featured on television in the past few years (Hausbeck et al., 1992). Indeed, Samuel found that "In the majority of cases, most of the teachers' knowledge originated from the media" (1993, p. 27). However, even though environmental concerns are addressed on television, most of the programs do not disseminate full knowledge and understanding of the various issues. Therefore, students and teachers, as well as the population as a whole, are

aware and concerned about the environment but do not have enough knowledge to analyze the various environmental issues.

Additional studies concurred that students are limited in their knowledge of the environment. They can only see the “intermediate circumstances” but miss out on grasping the “interactions” within the ecosystem (Membiela, Nogueiras, & Suarez, 1993, p. 31). Student attitudes toward the environment need to be reinforced with problem solving exercises (Membiela et al., 1993).

Teachers lack of environmental knowledge may impede the effective integration and implementation of environmental education in schools. Samuel (1993) conducted a study at an “environmental immersion” school where “The curriculum was to be enriched with environmental content in all subjects, thereby *immersing* the students in environmental science” (Samuel, 1993, p. 26). Although teacher attitude was positive, she found that “...teacher training and assistance were minimal, and very few materials had been collected to aid or inspire teachers” (1993, p. 27). This obstacle was a contributing factor to the lack of effective implementation of a school-wide environmental education program.

Traditionally, it has been the scientific community that has been encouraged to produce science education since *they* were in the field and knew what was needed for science. This has been counterproductive for science education and for students. Trained educators were not taken into consideration. Disinger stated that the objective now is to work *with* educators, not to replace them (Disinger, 1989).

Environmental education faces barriers within the classroom. These barriers “inhibit teachers from implementing EE (environmental education) programs.” Impediments include teacher misconceptions, logistics, teacher education, and attitude (Ham & Sewing, 1987-88, p. 17).

A misconception many teachers have about environmental education is that it can only be taught during science time. Teachers do not integrate environmental education with other disciplines. Another misconception is that environmental

education is “an outdoor experience” and an extra lesson in an already full curriculum (Ham & Sewing, 1987-88, p. 17). Time is limited for teaching environmental education. Even more limited is the planning time for developing a lesson on environmental education. Additional barriers include “lack of funding, resources, and suitable class size” (Ham & Sewing, 1987-88, p. 17-18). Many teachers feel that environmental workshops do not train them to teach environmental education to their students. Also, teachers lack an understanding of how to develop outdoor activities (Ham & Sewing, 1987-88). Teachers with bad attitudes toward environmental education rarely teach it.

Learning and Teaching Strategies

There are teaching and learning strategies which are associated with environmental programs. These include problem solving techniques, constructivism, an interdisciplinary approach, thematic teaching, cooperative grouping, and hands-on, or experiential, learning. Many of these strategies are designed to connect prior knowledge of science and other disciplines with problem solving and concept formation. Several resources are available.

Resources

Teacher resources focusing on environmental education have been developed (Samuel, 1993). Some examples of these resources include Project Learning Tree, Project WILD-Elementary, and NatureScope. These resources provide “interdisciplinary activities and infusion ideas” (Ramsey, Hungerford, & Volk, 1992, p. 45). Like many other resources, Project Learning Tree gives students the opportunity to evaluate complex issues in an outdoor setting (Shina & Triandafillou, 1995).

Another resource is the Issue Investigation and Action Training (IIAT) program which offers training in analyzing environmental issues to resolve problems. In a study conducted with seventh grade students trained in IIAT, it was noted that

students developed more of a “responsible environmental behavior” than students that did not attend the training (Ramsey & Hungerford, 1989, p. 32). The IIAT program cultivated students’ knowledge on specific skills and beliefs that are imperative to appropriate environmental behavior (Ramsey & Hungerford, 1989).

Problem Solving Techniques

Environmental education enables students to identify, analyze, and solve environmental problems. “Many educators have called for methodologies that make science and environmental education relevant for today’s world of...environmental degradation... (These methodologies) offer potential utility for training future citizens to deal with the problems created by man’s interactions...with the environment” (Ramsey & Hungerford, 1989, p. 34). “Environmental education has potential as an exemplary vehicle for what many believe all of education should consider its primary function: furthering the development of higher-order skills — critical thinking, creative thinking, integrative thinking, problem solving” (Disinger in Wilke, 1993, p.32).

It is the educator that has to develop a structure for students to become “problem solving citizens” (Ramsey & Hungerford, 1989). Implementing a variety of techniques such as constructivism, thematic teaching, cooperative grouping, and experiential learning can be beneficial in problem solving within an environmental education context.

Ramsey (1993) and Leeming et al. (1993) assessed the effectiveness of an environmental education program based on the individuals behavior and actions. On the other hand, Robertson (1993) held that environmental programs should be evaluated on the basis of the actual learning process which the individual goes through — not merely the resultant behavior. The desired behavior is to “teach children *how* to think, but not *what* to think” (Shina & Triandafillou, 1995, p. 18).

Constructivism

Although constructivist teaching is effective in all curriculum areas, it is especially adaptable to science education, including environmental education (Robertson, 1993). Indeed, for years many environmental education curriculum lessons and guides have used concepts associated with the constructivist theory of thought. These include discovery learning, cooperative learning, and problem solving (Klein & Merritt, 1994).

Instead of perceiving the child as a container to be filled with knowledge, constructivist teachers facilitate the learning experiences of the child. Children learn by “relat(ing) new knowledge to relevant concepts and propositions that they already know” (Robertson, 1993, p. 25). Klein and Merritt (1994) concurred that children learn by processing new information within the existing structure of their understanding.

In order to fulfill the learning theory above, Klein and Merritt (1994, p. 16) have outlined four elements of an effective constructivist lesson. First, to activate their minds, a real-life problem is posed to the students. “As students engage in investigating problems, they are responsible for making sense of their world and constructing new relationships.” The second element is “student-centered instruction,” with the teacher serving as a facilitator. “Students should be actively engaged in classroom learning tasks such as experimentation, investigation, observation, and discussion.” In order to maximize their full learning potential, students need to be greatly involved with the subject or topic at hand. Working with and interacting with peers is the third element. Collaboration among peers allows the child to learn social skills and to expand his or her own thoughts and ideas. The last element in a valid constructivist lesson is the design and implementation of authentic assessment. In keeping with their active role, students “are responsible for participating in authentic tasks and developing and defending their personal views.” This requires higher level thinking skills which are demonstrated through open-ended

questions and tasks.

Interdisciplinary Instruction

The interdisciplinary nature of effective teaching is a common theme found in literature. Interdisciplinary teaching involves the integration of the various subjects including science, language arts, mathematics, social studies, visual arts, and performing arts. “In the elementary grades, a basic problem facing science instruction is the need to achieve curricular parity with reading, writing, or mathematics” (It’s Elementary, California Department of Education, 1992, p. 12). Interdisciplinary instruction addresses this issue. Different subjects, such as science and mathematics, could be taught simultaneously within the same lesson or context. This makes time management more efficient and effective (It’s Elementary, California Department of Education, 1992).

The Science Framework for California Public Schools: Kindergarten Through Grade Twelve (California Department of Education, 1990), affirmed the beneficial outcomes of learning concepts within an interdisciplinary context. It stated that “Language arts activities and mathematics, with their ways of depicting data, should not be separated from science instruction. The communication skills of one content area enhance the skills of the other”. Children can make connections among the disciplines which will increase their learning and understanding. The other California State frameworks by the California Department of Education likewise support this approach. These include the Mathematics Framework for California Public Schools: Kindergarten through Grade Twelve (1992), History-Social Science Framework for California Public Schools: Kindergarten Through Grade Twelve (1988), and Language Arts Framework for California Public Schools: Kindergarten through Grade Twelve (1987). Like the above frameworks, the History-Social Science Framework for California Public Schools: Kindergarten Through Grade Twelve “...attempts to bridge the barriers between the related disciplines and to enable students to see the

relationships and connections that exist in real life" (1988, p. 28).

Because environmental education is based on science concepts, it can be integrated into other disciplines. The disciplines support and enhance each other. The disciplines include reading and writing (language arts), mathematics, and history-social sciences.

"Across the nation, some schools and teachers are integrating reading and writing instruction into the substantive domains of science. Merging these areas can enable students to learn content and process simultaneously and create an intrinsically interesting context for teaching..." (Gaskins et al., 1994, p. 1039). "Precisely because processes for flexible and analytical reading, writing, and thinking are crucial to the construction of knowledge in science, these processes must be explicitly taught as part of science instruction" (Glynn et al., 1991, in Gaskins et al., 1994, p. 1041).

The students must "think, read, and write about science" (Gaskins et al., 1994, p. 1040). A student will learn more from science when reading and writing about it than from recollecting scientific facts (Gaskins et al., 1994). The problem with teaching science is that students learn terminologies from memorization, but cannot use this *memorized* knowledge to predict. Using writing as a tool to explain thoughts and answers, a teacher can read and understand the thought processes of each student (Fellows, 1994). Fellows suggested that a "holistic event of writing may force integration of new ideas and relationships with prior knowledge" (Fellows, 1994, p. 987). An effective strategy is to have students explain in writing their solutions to science problems (Gaskins et al., 1994). When students do this, they develop "new principles or theories to their schema," and learn to "organize around the central concept" (Fellows, 1994, p. 996).

Science has two major goals: 1) acquire principles and concepts and 2) develop new ideas through thinking, reading, and writing (Gaskins et al., 1994). Science is about thinking (Gaskin, 1994). Writing is a vehicle that can make science into a thinking process. By writing, students can show teachers that they are formulating

ideas and struggling to present them analytically (Fellows, 1994).

Gaskins conducted a study of the integration of reading and writing into two science units. Middle school students reading below grade level were tested. Gaskins suggested that students improve their reading and writing in science by noting the problem, choosing reading material relevant to the task, explaining the main concept and its relevancy, and using the acquired knowledge to solve the problem. Students who participated in this study made notable improvements in their understanding and utilization of scientific concepts (Gaskins et al., 1994). When reading and writing are taught with science, students change their ideas and knowledge through reflection (Fellows, 1994).

Fellows developed the "concept map," which is a web of knowledge strung together to interrelate the recently learned ideas or concepts with prior knowledge. Students increase their understanding of the subject matter by making connections with their prior knowledge. The objective of the map is to "improve conceptual change" (Fellows, 1994, p. 992-993). The outcome of the study showed that "writing about thinking improves learning."

Mathematics can be integrated into the science curriculum according to the Mathematics Framework for California Public Schools: Kindergarten Through Grade Twelve (California Department of Education, 1992). Indeed, "The role of mathematics in science...is well-known" (p. 101). Just as science is a part of students' everyday world, so is mathematics. Mathematical competency is essential to scientific understanding. In fact, a strong foundation in mathematics is required for many scientific professions (It's Elementary, California Department of Education, 1992).

Mathematics uses "talk(ing), writing, drawing, graphing, symbols, numbers, and tables to help (students) think and communicate their ideas" (Mathematics Framework for California Public Schools: Kindergarten Through Grade Twelve (California Department of Education, 1992, p. 35). These are the same processes and methods which are used in science classrooms. Many ideas in mathematics and

science are interrelated; the two disciplines can be used to support the ideas and extend the concepts of each other.

History-social science also lends itself as an interdisciplinary component to a science program. Critical thinking is an essential element in both discipline areas. "Included in these (critical thinking) skills are the ability to decide whether the information is sufficient in quality and quantity to justify a conclusion; to identify reasonable alternatives for the solution to the problem; to test conclusions or hypotheses; and to predict probable consequences of an event, a series of events, or a policy proposal (History-Social Science Framework for California Public Schools: Kindergarten Through Grade Twelve, California Department of Education, 1988, p. 25). Interpreting problems, selecting criteria, and assessing outcomes is essential to both the science and the history-social science curriculums.

The majority of the time, partners and groups should be utilized in science and history- social science classrooms (Science Framework for California Public Schools: Kindergarten Through Grade Twelve, (California Department of Education, 1990) and History-Social Science Framework for California Public Schools: Kindergarten Through Grade Twelve, (California Department of Education, 1988). Students not only develop and refine social interaction skills, but they share ideas and gain knowledge from each other. Collaboration among peers promotes thought analysis and concept development. Also, working with others prepares students for the "real world" in which adults interact with each other (It's Elementary, California Department of Education, 1992).

Thematic Teaching

Another strategy designed to aid students through the learning process is thematic teaching. The Science Framework for California Public Schools: Kindergarten Through Grade Twelve (1990, p. 28) stated that "...an integrative, thematic approach to learning will help students not only to develop a meaningful

framework for understanding science but also to approach problems in other disciplines as well as in their daily lives as citizens, consumers, and workers.” It is well known among educators that utilizing a theme across the disciplines not only enhances the depth of student understanding but it is also more efficient (It’s Elementary, California Department of Education, 1992).

Cooperative Grouping

The grouping of students into cooperative groups utilizing heterogeneous grouping to improve learning is a classroom strategy which can greatly benefit all students (Lazarowitz, Hertz-Lazarowitz, & Baird, 1994). Because of the experimental nature of science classes, cooperative groups are ideal in many classrooms.

Cooperative groups are given credit for students gaining “in both academic and nonacademic ways” (Lazarowitz et al., 1994, p. 1127). Nonacademic benefits include improved social skills, better organization, and commitment to the academic assignments.

According to Lynch (1994), seventy-five percent of all schools in the United States have ability grouping, not heterogeneous grouping. This is not only considered unfair to minority students, but also disputed by many as being undemocratic.

Experiential Learning

Modern and traditional environmental educators have wanted education to ultimately persuade individuals to respect the environment by developing a positive behavior towards the environment (Disinger, 1989). Children need to be exposed to nature and develop a love for it to become caring (Palmer, 1993). Besides experience with nature, children need to also learn about the environment because it is assumed that awareness precedes environmental actions and behavior (Newhouse, 1990, p. 26).

Palmer stated that research supported that “childhood experiences of the outdoors is the single most important factor in developing personal concern for the environment” (Palmer, 1993, p. 29-39). This data was collected from the United

Kingdom, Greece, Germany, the United States, Mexico, and Japan. The second greatest influence on developing environmental concern is classroom education, while the influence of parents and relatives account for third place. Outdoor activities include “camping, sailing, watching birds and animals, farming, practicing conservation work, gardening, and dwelling in the countryside either permanently or for holidays” (Palmer, 1993, p. 28).

A person becomes concerned about or sensitive to the environment after learning to appreciate nature as a child (Palmer, 1993). Informed adults who had prior experiences with the environment tended to be concerned for the environment as a result. Teachers should be aware of the influence they have on students and the effects they can have towards environmental awareness (Palmer, 1993). Resources such as books, outdoor travels, and disasters also bond persons in their concern for the environment (Palmer, 1993).

Persons working in jobs that deal with the environment, wilderness, or the outdoors in general were influenced during childhood by parents, relatives, or friends. Experiences such as planting a garden, using environmentally friendly products, and various conservation activities had a positive influence on their future environmental attitudes and behavior (Palmer, 1993). This is why it is crucial for students to be exposed to experiences which protect and promote the environment, particularly by their parents (Palmer, 1993).

Persons became more concerned and involved with caring for the environment after having been exposed to nature or wilderness. As youth, they were taught to care for the surrounding environment and the ecology of nature. Having these concerns and interests for the environment, they have grown to appreciate the outdoors as a place that has to be conserved. Experiential education creates a foundation for this connection with the outdoors. Hands-on, personal experiences influence students to care for the environment and develop a positive attitude for the conservation of the environment (Weintraub, 1995).

Environmental education must also be on a local level. Knowledge starts at home and within a community. Personal connections made while caring for their own communities transfer into caring for other problems in other locations. To start this connection, a problem should be relevant for the community so that people would feel the investment to care is worth their time and effort. This is especially when the problem hits close to home. This makes learning about the environment relevant to the learner (Disinger, 1989).

GOALS AND OBJECTIVES

It has been the purpose of this project to develop a teacher's manual with comprehensive directions and supplemental activities for a student booklet on storm water pollution. The student booklet was developed by the Riverside-Corona Resource Conservation District. Working in conjunction with this agency, the author designed this teacher's guide to assist educators in teaching about the prevention and consequences of storm drain pollution. The project specifically examines storm water pollution that is contaminating the environment as the runoff flows from storm drains into rivers, streams, and oceans. This contamination also affects humans and wildlife. In a unit spanning three weeks, children are encouraged to participate in awareness activities, hands-on experiences, and problem solving exploration. Positive, responsible environmental behavior as related to storm drain pollution is the overall objective.

To achieve this goal:

1. A teacher's manual on teaching the student guide and supplemental student activities were developed which show connections between people and wildlife. The lessons focus on the awareness, prevention, and consequences of storm drain pollution. Reading and writing skills are encouraged along with the development of analytical thinking and problem solving skills. The unit includes the interdisciplinary areas of language arts, social studies, science, mathematics, and art.
2. Two fellow teachers at the writer's elementary school helped in reviewing the project. One teacher taught at the primary level (grade 3) and the other taught at the intermediate level (grade 6).
3. Interaction and feedback from the university advisor and the second reader strengthened the development of this project.
4. The Riverside-Corona Resource Conservation District supported the development of the teacher manual and supplemental student activities.

DESIGN OF PROJECT

The teacher's manual contains lessons with supplemental student activities designed to develop awareness, knowledge, and action concerning storm water pollution. By focusing on a local topic such as storm water, students become interested and involved in their environment. As students become familiar with local problems, newly-developed attitudes may result in positive environmental behavior.

The teacher's manual combines lessons contained in the student booklet with additional activities to support and enhance students' learning about storm water. This design is important because teachers can modify and enrich the unit with specified learning activities as needed. Various curricular areas are incorporated into the unit: language arts, social studies, science, mathematics, and art. Cooperative and hands-on learning methods are employed to increase student learning and interaction. The teacher's manual was developed for use in primary and intermediate elementary classrooms. A table of contents, general overview, and a glossary facilitate the use of the teacher's guide.

Lessons within the student booklet are described in the teacher's manual. Each lesson description includes the student booklet pages, approximate time duration of each lesson, materials required, and the skill areas and vocabulary involved. Background information and a list of appropriate questions also accompany each lesson. A section of options for each lesson allows the teacher to modify or expand the unit as desired.

Using the student booklet as a guide, additional activities were also developed to further increase and enhance student learning. There are student worksheets for both primary and intermediate students. A "Trivia Card Activity" was created to reinforce and assess student knowledge on the various concepts presented throughout the unit.

The unit was completed with the author's sixth grade class. The unit

concluded with an oral assessment in the form of a review and discussion with the students.

RESULTS

This project was completed with the writer's sixth grade class. Although the students were introduced to the water cycle earlier in fifth grade and were conscious of pollution and its harm to the environment, the students had little knowledge of storm water. An oral preassessment revealed that none of the students were aware that the water entering a storm drain system flowed directly into the environment or ecosystem. Students volunteered information about washing their parent's car, or washing oil, paint, and other toxins off their driveways into the storm drain system.

The students saw first hand that pollutants were entering a storm drain inlet near the school. The types and quantities of each type of pollutant were recorded by the students and later used to construct charts and graphs. Students were encouraged by the author to investigate the sources of pollution and to identify solutions. The students showed great interest in solving the problems at hand. Instead of feeling hopeless despair, the students became motivated to inform their parents, relatives, and neighbors about the hazards of storm drain pollution. Parents informed the author of their own child's interest and motivation to control storm water pollution around their homes. One parent now takes the car to be washed in a local car wash instead of doing it in the driveway. Students informed the author that a few of their neighbors pollute storm water and wondered what could be done about it.

Student feedback on the lessons was positive. Student comments included, "That was fun!" and "When can we do that again?". Students continued showing an interest in this project after the three week unit. It is still a topic of conversation in the author's classroom. The author is presently sharing this project with other teachers within the school and the district. Teachers have praised the project as a positive introduction into student awareness and action.

IMPLICATIONS FOR EDUCATORS

Environmental education should be viewed by educators as an opportunity to integrate a variety of disciplines in education while fostering awareness and preservation of our planet. Recent research and interest in the environment have produced creative educational lessons that spark interest, as well as encourage students to organize their thoughts and develop new concepts. Because of the ease of integrating environmental education lessons with other curriculums, educators will find this unit on storm water relatively easy to use to encourage positive environmental behavior.

This project uses the various teaching curriculums such as language arts, social studies, science, math, and art to connect environmental care with learning. Most of the lessons do not require prior knowledge for students to be successful. They are simple to follow and easy to assess. The materials needed to implement this project are easy to obtain and inexpensive. Field trips to rivers, lakes, or the ocean can support this project by showing students the ultimate destination of storm drain run-off.

Storm drain runoff and pollution are problems in almost every community, urban and rural. It is vital that students become aware of the problem and that they can help to preserve the quality of our waterways. This is important because water is essential to life and the conservation of the environment. Students learning about storm water could also inform and encourage adults to prevent storm water pollution.

Teaching this lesson within a community can personalize the seriousness of storm water pollution. Students are close to the problem and can trace the sources and see the actual consequences in their neighborhood or city. This may motivate them to share their awareness and knowledge with their families. Students are more likely to act upon concern knowing that contamination of the storm drain system could diminish their environment.

APPENDIX A
TEACHER'S GUIDE

STORM WATER POLLUTION PATROL

Teacher's Guide

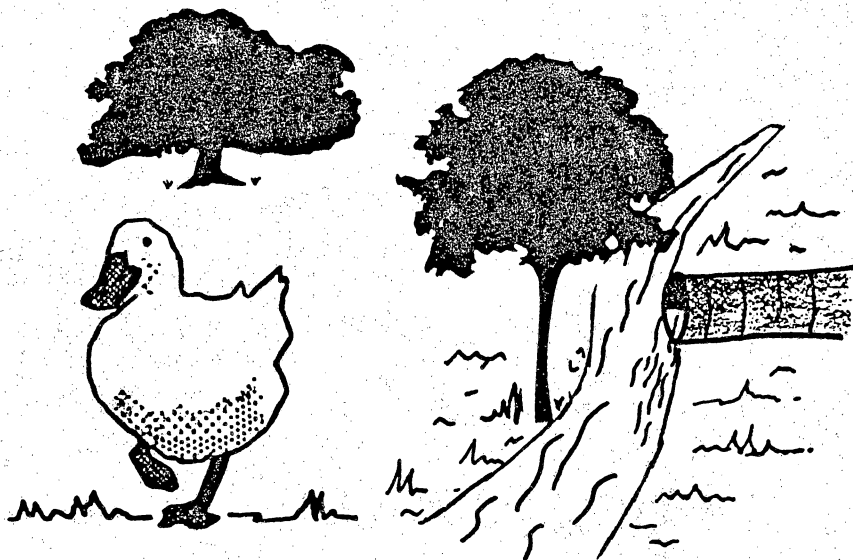


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OVERVIEW

This guide and student activity booklet were developed to enable students to develop an awareness of and knowledge about storm water pollution. Storm water pollution occurs when certain human activities cause water, which has fallen as precipitation, to become polluted. The activities described in this guide are designed to assist the students in their understanding of basic concepts concerning storm water pollution and to motivate them to protect their neighborhood waterways and watershed. The activities utilize an interdisciplinary approach, integrating a variety of subject areas: science, language arts, social studies, math, and art.

Water is a basic prerequisite of life, both for humans and wildlife. Therefore, it is important that students comprehend the necessity of conserving and protecting our water resources in our often drought ravaged area. As precipitation falls, much of the water flows into storm drains. The storm drain system then carries this water into waterways and eventually into the ocean. Although storm water is not cleaned and piped into our homes, it is used for many other activities such as fishing, swimming, and other water sports. Also, wildlife depends on this water for survival.

Primary Teachers

Primary students should complete the reading portions as a class. Teachers may want to read each section to students and use the readings and pictures as a basis for discussion and questions.

Intermediate Teachers

The reading portions in this booklet may be read individually, in small groups, or as a class. The students should read and discuss each section. The teacher should provide direction and clarification.

DIRECTIONS TO STUDENT **BOOKLET**

STORM WATER AND POLLUTION

Pages: 2-3

Duration: 1 hour

Materials: paper (grid paper if possible), pencil

Skill Areas: estimation, mapping skills, scale drawings

Vocabulary: channel, erosion, inlet, pollutant, sediment, storm drain, storm water, waterway

Background:

When precipitation falls to the Earth's surface, the resulting water either infiltrates into the ground becoming groundwater or flows along the surface. Water which does not infiltrate, or soak, into the ground runs along the surface as runoff, eventually reaching waterways (streams or rivers). These waterways then empty into lakes or oceans.

Because of increasing urbanization and loss of natural areas, precipitation (storm water) has a decreasing area in which to infiltrate into the ground. Buildings, streets, parking lots, and other types of construction do not allow water to soak into the ground. Therefore, storm water systems have been built. These storm drains collect the water from inlets along street curbs and carry it directly to waterways (rivers and streams).

Storm water that flows into storm drains is not purified at water treatment plants. In our area, the water that goes down the storm drain ends up in the Santa Ana River. Clean water is needed by wildlife and the natural environment surrounding waterways. Our health, safety, and enjoyment of water activities also depends on clean water. Thus, it is vital that students realize how detrimental polluted water can be when it enters the waterways. Many different pollutants, including paints, pesticides, and sediment, can contaminate waterways. The best solution to pollution is prevention - stopping possible contaminants at their source - before they enter the waterways.

Activity 1 & Questions:

To begin, ask students the following questions:

- * What is pollution? Have students give examples of pollutants. Discuss why

each may be considered a pollutant.

- * What are storm drains? Have students define storm drains. What are they? Where are they located? What do they do?
- * What do you think happens to the water that enters the storm drains? Where does it end up? (It flows into the Santa Ana River and then into the Pacific Ocean.) Is it cleaned at a treatment plant?

Read pages 2-3 as a class and discuss the different types of pollutants which affect waterways. Then conduct a walking field trip around the school's neighborhood. Make sure to bring along a trash bag so students can pick up litter as they perform their survey. After completing the survey, ask students to add on to or revise their answers to the above three questions. Additional questions, listed under Option #1, can also be used.

FIELD TRIP:

The walking field trip is designed to allow students the opportunity to locate storm drains and to observe the types and amounts of litter that exist nearby. With this experience, students will be capable of analyzing the possible effects of various litter types on the storm drain system.

IMPORTANT!

Before conducting the walking field trip, you need to go over the following safety precautions with students.

- Safety Precautions:
- 1) Wear gloves.
 - 2) Never reach where you can not see.
 - 3) Do not pick up glass or other dangerous items.

Options:

1) Pollutant Survey: During the litter survey, have students complete the following activity and questions.

Activity: Have students categorize the types of litter found.
(paper, plastic, glass, yard wastes, pet droppings, other)

Questions:

- a) Is each of the litter items you found a pollutant? Why or why not?
- b) How could these items be prevented from becoming pollutants?
- c) What is the source of each litter item?
- d) Are any of the litter items harmful to humans? to wildlife? How?
- e) How many inlets to storm drains did you see?
- f) Were there any litter items near inlets to storm drains?

- g) What might happen to the litter if it was not cleaned up?
- h) If litter went down the inlet and into the storm drain, where would it end up?
- i) Which of these items should have been recycled?

Activity: Students write or draw an explanation of how litter on the ground could cause storm water pollution.

- 2) Students can discuss and write about:
 - a) Who is responsible for pollution?
 - b) Why is it important that individuals take responsibility for their actions?
- 3) Ask students if motor oil is a pollutant. What makes motor oil a water pollutant? (The actions of humans determine whether the motor oil becomes a pollutant.)

Lead a discussion on how to keep motor oil from reaching storm drains. Why is it important to keep it out of storm drains? How could you prevent it from reaching storm drains?

Students could write an explanatory paper on keeping motor oil out of storm drains. Emphasize to students the importance of describing their method and why unpolluted water is essential to life.

Use the following scenario to guide students through this activity. You are helping your uncle change the motor oil in his car. He has the car parked in the driveway of the house. Before putting new oil in the car, you must first drain the old oil out of the car. If you open the oil plug under the car, the old oil will pour out onto the driveway and run down to the curb. Water from rain, a garden hose, or sprinklers will wash it into the inlet of the storm drain. Is there a way that you can change the oil without any motor oil getting into the storm drain?

- 4) Students can create a public notice informing residents of storm water pollution and its effects. This can be written or illustrated.
- 5) Create a class list on how pollutants can affect wildlife. Write students' ideas on the board so that everyone can see them. This way, students can use each other's ideas to expand and motivate their own thinking. Encourage students to fill up the entire board with ideas or to think of as many ideas as they can in five minutes.

POLLUTION SOURCES

AND WHERE STORM WATER GOES

Pages: 4-7

Duration: 1/2 hour

Materials: crayons

Skill Areas: mapping skills

Vocabulary: bay, lake, ocean, reservoir, watershed

Background: Storm water pollutants come from many sources such as driveways, yards, and runoff from farmland. Whether the potential contaminant is spilled motor oil or animal droppings deposited near a creek, the pollutant can be prevented from reaching the storm drain or waterway. Prevention may include picking up litter, taking used oil to a recycling center, or moving animal droppings away from waterways. If pollutants get into waterways, it is very difficult and costly to clean them up.

The map on pages 6-7 shows the watershed for our area of Southern California, including the Inland Empire. A watershed is defined as "all the water that drains into a single waterway." The slope, geology, and other characteristics of the land determine into which waterway the runoff water will flow. Many smaller waterways in the area flow into the Santa Ana River. The Santa Ana River flows in a southwesterly direction from the San Bernardino Mountains to the Pacific Ocean.

Activity 2 & Questions:

To begin, ask students about pollution sources using the following questions:

- * How does storm water become polluted? What are some sources of pollution? (Human activities are the major cause of storm water pollution.)

- * What are some activities which would prevent or help clean up pollution? Categorize these ideas into prevention and clean-up activities. Which method do the students prefer - prevention or clean-up? Why?

Read and discuss pages 4-5. Students find as many different sources of water pollution in the picture as they can. Students can create a list as a class, in pairs, or individually.

Activity 3 & Questions:

To begin, ask students the following questions:

- * What are the names of all the waterways in our area?
- * Do any of these waterways empty into larger ones?
- * What is the name of the local waterway which empties into the Pacific Ocean? (Santa Ana River)
- * Do your actions affect any of the above waterways? How?

On pages 6-7, have students determine which waterways they live near and the watershed which they can help keep clean. Using the map as a guide, students can add on to or revise their previous answers to the questions above.

Activity 4 & Questions:

First, ask students if any of them have ever seen a polluted river, lake, or ocean? Then, ask if any of them have ever seen clean (unpolluted) water? Have students describe their experiences. Next, divide the class in half. One half of the class should draw a picture of clean water while the other half should draw a picture of polluted water. Tape the pictures to the wall or board so everyone can see them. Ask students:

- * What are the similarities between the clean and polluted water pictures?
- * What are the differences between the clean and polluted water pictures?
- * Looking at the pictures, how does pollution affect water?
- * Can polluted water be turned into clean water? How?

Review the various ways students can help prevent storm water pollution (discussed in Activity 2 above). Ask students: What is the difference between surface water and groundwater? (Surface water is visible on the Earth's surface while groundwater is beneath the surface.) On the bottom of page 7, students list the names of the surface waters they can help keep clean. Have students share their responses with the class.

Options:

- 1) Students study different types of maps (physical, geological, etc.) detailing their area. These resources can be found in the school or local library. Using the maps, local information, and historical facts students can write a description of their area or waterway.
- 2) Divide the class into small groups. Have each group study a specific waterway in a different area (county, state, country) and compare it to their own.

STORM WATER POLLUTION

ABOVE AND BELOW THE GROUND

Pages: 8-9

Duration: 1/2 hour

Materials: clear container, sand, straw, water

Skill Areas: prediction, angles

Vocabulary: aquifer, groundwater, habitat, surface water, well

Background:

Storm water contributes to both surface water and groundwater. Storm water becomes surface water when it does not soak (infiltrate) into the ground. It flows as runoff into other surface waters such as rivers and oceans.

Storm water becomes groundwater when it soaks into the ground. Groundwater is important because it is a major source of our water. If groundwater becomes polluted, it is very difficult if not impossible to clean up.

Activity 5 & Questions:

Have students look at the diagram on page 8. Ask the students the following questions:

- * What are wells? (deep holes dug into the ground from which water is brought to the surface)
- * Where are the water wells?
- * Where is the freshwater aquifer?
- * Does an aquifer contain surface water or groundwater?
- * How do we get water from an aquifer to the surface?
- * Why do we pump water up from an aquifer?

Read pages 8-9 as a class and discuss the main ideas. The activity is on the bottom of page 8. The students will build a model of a lake and hillside with sand. With a straw, they will demonstrate how the amount of water in a lake affects the level of groundwater in a nearby well. At the same time, the model will show how pollution on the surface affects the soil, the water in the lake, and the groundwater.

The activity should be done in small groups of 2-4 students. If the materials are not available conduct the activity as a demonstration in front of the class.

Important Tip:

*** When water is added to the lake, the water level in the well (straw) should rise. When pollution (red powder) is added to the system, it should soak through the soil (sand), reaching the groundwater. The soil, groundwater, and well water should all show signs of contamination.

Activity 6 & Questions:

Ask students the following questions:

- * When storm water becomes polluted, does it affect anyone or anything?
- * How does it affect humans? wildlife? plants?

In Activity 6 (bottom of page 9), students identify the various plants and animals which may be affected by polluted storm water.

Options Activity 5:

- 1) Students can write a paragraph describing in detail their observations of the model they created.
- 2) When performing the activity, students can experiment with different factors:
 - a) amount of water added to the system
 - b) where the water was added (in lake, on the hill, etc...)
 - c) amount of pollution (red powder) added to the system
 - d) where the pollution was added
 - e) location of well (close or far from the lake)
 - f) type of soil used (try sand, clay, a mixture of both)

Options Activity 6:

- 1) Students can create food chains using the habitat pictured on page 9. Animals not pictured could also be used. Encourage students to think of different combinations of animals living in various habitats.
- 2) Students can write a summary on how water pollution affects the habitat on page 9 or on food chains developed in #1 above.

YOU CAN HELP PROTECT OUR WATER

SUPPLIES

Pages: 10-12

Duration: 1/2 hour

Materials: pen, crayons

Skill Areas: art

Background:

There are many different actions individuals and groups can take to protect both surface and groundwater (storm water being a major contributor of both). Organizing and participating in a clean-up project is one example of a group effort. Educating individuals to take responsibility for their own actions is an effective way to prevent pollution before it happens. Stress to students that though the ideas listed are simple, they are very important in protecting our water. Students and their families can make a difference.

Activity & Questions:

Read pages 10-12 as a class. Students check the ways they will help keep storm water clean. You may want them to do this as the ideas are being read or go back and mark choices after both pages have been read.

On the back cover (page 12), students draw a picture without storm water pollution. When they are finished, have students compare their unpolluted picture to the drawing on the cover page (page 1). Ask them the following questions:

- * What is the same in both pictures?
- * What is different?
- * Which area would you like to live near? Why?

EXTRA ACTIVITIES

LANGUAGE ARTS

WATER DROP STORY

“You’ll Never Believe What Happened To Me!” Students imagine that they are a water drop falling from the sky, heading towards land. Students describe their journey, in writing, as a part of the storm water system. Discuss with students the following: where will they land (in the city or in the country); their route (through a storm drain or directly into a waterway); what types of pollution, if any, are around them; what types of activities are helping to keep their water clean. They can illustrate their stories too!

SOCIAL STUDIES

PAST AND PRESENT

Research past and present methods of water use. Compare the similarities and differences between the past and the present. Students can use the school and public libraries to collect information. The teacher may also have resources the students can use. Suggested topics include:

Water use: What was the primary use of water in the past and what is the primary use today? Does this vary depending on the state or country being researched? Does this water use depend on the population? If so, what is the link between water use and population?

Water treatment: Has water always been cleaned or treated? What methods were used in the past? What methods are now used? Which methods are most effective?

Runoff control: Can runoff be controlled? What methods are used to control runoff? How effective are these methods?

SCIENCE

WATER AROUND MY HOME

Student worksheet on page 18.

Students do research about the water used in and around their homes. This worksheet should be completed as a home activity.

ANIMAL RESEARCH

Students can write a research paper on the importance of clean water to an animal which lives in our area. Students can use the "List of Animals In Our Area" (page 19) to select their choice. The following suggestions can be used to guide students through the activity:

- 1) Select an animal which lives in our area.
- 2) Gather resources to use for information: books, encyclopedias, magazines, etc. Look for information about your animal and about water.
- 3) Read the information. Write down important information and interesting facts about your animal. Keep in mind the connection between your animal and clean water.
- 4) Putting the information you learned into your own words, write a 1-2 page report.
- 5) Draw a picture of your animal either in or near clean water.

MATH

A MESSAGE FROM WILDLIFE

Student worksheets on pages 15-17. The message is "KEEP STORM WATER CLEAN - WE LIVE BY THE STREAM."

Primary students: Copy page 15. Students will match up numbers with letters to decode the message.

Intermediate students: Copy pages 16-17. Students must solve math equations and match the number answer to the corresponding letter in order to decode the message.

RAIN AT SCHOOL

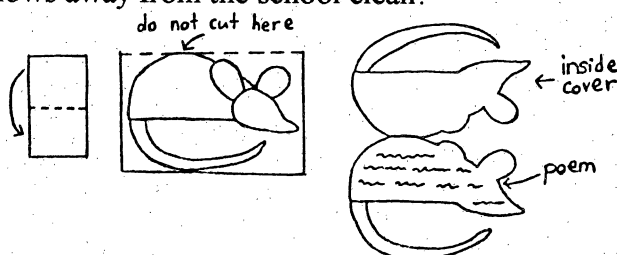
(Adapted from "Where Does Water Go After School?" in Project WILD Aquatic)

Students can calculate the amount and weight of rain flowing off the schoolgrounds using the following set of directions.

- 1) Measure the length and width (perimeter) of the schoolgrounds using a piece of string (approximately 100 feet long) marked off every three feet. If the area is irregular, approximate the length and width. Use the following formula to find the area: $A = L \times W$ (A=area, L=length, W=width).
- 2) Using newspapers, local weather reports, or other resources, find the average yearly rainfall for your area (R). Convert inches into feet.
- 3) The volume of rainfall can be found using the calculation: $V(\text{volume}) = A(\text{area}) \times R(\text{rainfall})$. The label for volume is "cubic feet of rain."
- 4) Water weighs 62.5 pounds per cubic foot. To find the weight of the rain, students multiply 62.5 with the volume of rainfall (R). The answer will be in pounds.

After finding the weight of the rain falling on the schoolgrounds each year, the teacher can discuss the following with the students:

- 1) What happens to the rain once it falls on the school grounds? (sinks into the ground or becomes runoff)
- 2) What happens to the runoff from our school? Where does it end up?
- 3) Does the amount of rain that falls on our school affect wildlife near streams or rivers? How?
- 4) Does the quality of water runoff from our school affect wildlife? How?
- 5) How can we keep the runoff that flows away from the school clean?



ART

ANIMAL COVERS

Students can make "Animal Covers" using the following set of directions. Fold a 8"x10" or 11"x14" paper in half. Using the entire half, trace or draw freehand the outline of a local animal which lives in or near waterways. Have the top part of the animal touch the paper fold (see diagram). Cut animal outline out so that the animal has a front and back half and is connected at the top. Color in the details of the animal on the front half. Open up the animal and inside write a poem or interesting facts about your animal.

TRIVIA CARDS ACTIVITY

Reproduce the 45 trivia cards on pages 20-25. Divide the class in two and select a captain for each team. Give each captain 22 trivia cards. Keep the last card to see which team goes first. Review the rules with the students before you begin:

- 1) All the answers are either TRUE or FALSE.
- 2) Students must raise their hands to give an answer. Either the teacher or team captains can choose the student who answers.
- 3) One point is given for each correct answer.
- 4) Teams alternate in asking questions (Team A captain asks Team B a question. Team B captain asks Team A a question. It does not matter if the answer is correct or incorrect - only one question is given to a team on their turn.)
- 5) The team captains will read the questions to the opposite team.
- 6) One person from each team will keep score on the board.
- 7) The winner is the team with the most points!

Read the remaining trivia card to both teams. Whichever team is first to correctly answer the question will be the first to be asked a question by the opposite team. Continue playing until each team has been asked 22 questions. This is a good review of the concepts presented in the student booklet.

WATER AROUND MY HOME

Directions: Find the answers to the following questions to learn more about the water in and around your home. You can ask adults in your home for information or help.

(HINT: Use page 2 in your student booklet to help you!)

1) Where is the nearest storm drain inlet to your home?

2) Would runoff from your yard collect in that inlet? How could you tell?

3) Is the curb in front of your home free of sediment, leaves, and debris?

4) What areas around your home does water probably soak into the ground? How can you tell?

5) What areas around your home does water runoff? How can you tell?

6) What is the name of the closest waterway to your home?

7) What could you do to prevent storm water from becoming polluted?

A MESSAGE FROM WILDLIFE...

Decode the following message to find out what wildlife might say to you. Match up each number with the correct letter in the clue box to find the message!

0 16 16 8

2 32 13 3 21

5 9 32 16 3

30 25 16 9 10

5 16

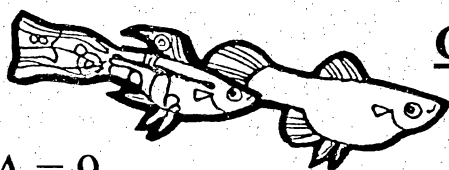
25 19 29 16

15 34

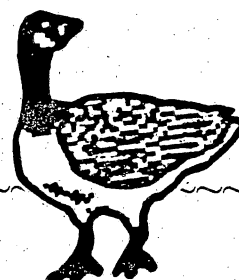
32 11 16

2 32 3 16 9 21

!



CLUE BOX



A = 9

E = 16

K = 0

N = 10

R = 3

V = 29

B = 15

H = 11

L = 25

O = 13

S = 2

W = 5

C = 30

I = 19

M = 21

P = 8

T = 32

Y = 34

A MESSAGE FROM WILDLIFE...

Decode the following message to find out what wildlife might say to you. Compute the following equations. Make sure to solve the operations in the parentheses first. Match up the answer number with the corresponding letter in the Clue Box to decode the message. The message is read vertically!

CLUE BOX

A = 9

B = 15

C = 30

E = 16

H = 11

I = 19

K = 0

L = 25

M = 21

N = 10

O = 13

P = 8

R = 3

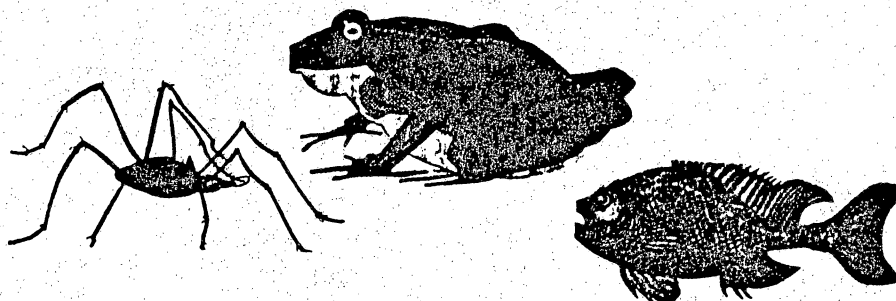
S = 2

T = 32

V = 29

W = 5

Y = 34



DECODING EQUATIONS

***HINT:** Solve the parentheses first! Work from left to right.

$$(20 / 5) - 4 =$$

$$(10 \times 2) - 4 =$$

$$(24 / 2) + 4 =$$

$$(28 / 2) - 6 =$$

$$(8 \times 3) / 12 =$$

$$(9 \times 3) + 5 =$$

$$(12 \times 2) - 11 =$$

$$(27 / 3) - 6 =$$

$$(6 \times 7) / 2 =$$

$$(8 \times 0) + 5 =$$

$$(19 - 1) / 2 =$$

$$(56 / 7) \times 4 =$$

$$(40 / 10) + 12 =$$

$$(7 \times 2) - 11 =$$

$$(12 \times 3) - 6 =$$

$$(5 \times 5) - 0 =$$

$$(7 \times 2) + 2 =$$

$$(2 \times 8) - 7 =$$

$$(8 + 5) - 3 =$$

$$(24 / 4) - 1 =$$

$$(4 \times 4) - 0 =$$

$$(14 - 9) \times 5 =$$

$$(30 / 2) + 4 =$$

$$(7 \times 4) + 1 =$$

$$(3 \times 5) + 1 =$$

$$(27 / 9) \times 5 =$$

$$(9 \times 4) - 2 =$$

$$(6 \times 5) + 2 =$$

$$(3 \times 3) + 2 =$$

$$(3 + 5) \times 2 =$$

$$(14 + 8) / 11 =$$

$$(11 \times 3) - 1 =$$

$$(17 - 14) / 1 =$$

$$(8 + 9) - 1 =$$

$$(22 / 2) - 2 =$$

$$(4 \times 5) + 1$$

WORD SEARCH

Find the hidden words in the puzzle below. The words may be found horizontally, vertically, diagonally, forwards, and backwards. GOOD LUCK!

runoff
stormdrain
erosion
groundwater
Santa Ana River
pollutant
watershed

waterway
wildlife
reservoir
aquifer
channel
sediment
surface water

toxic
well
ocean
habitat
inlet
lake

R	E	T	A	W	E	C	A	F	R	U	S	M	O	X
E	N	F	P	O	L	L	U	T	A	N	T	S	E	O
V	V	X	C	R	C	E	R	O	S	I	O	N	R	M
I	U	W	H	P	D	O	N	F	K	U	R	Q	E	Q
R	E	T	A	W	D	N	U	O	R	G	M	U	F	B
A	E	I	N	T	L	E	E	F	I	L	D	L	I	W
N	C	S	N	L	E	W	H	A	D	I	R	H	U	Y
A	O	K	E	C	C	R	H	S	V	N	A	A	Q	J
A	E	W	L	R	D	W	W	K	R	L	I	B	A	P
T	O	X	I	C	V	C	L	A	K	E	N	I	L	X
N	C	F	R	U	N	O	F	F	Y	T	T	T	Z	J
A	E	A	T	N	E	M	I	D	E	S	Y	A	V	J
S	A	S	U	L	W	L	X	R	H	C	B	T	W	X
K	N	D	Z	I	N	B	Z	K	D	K	A	P	N	Q

LIST OF ANIMALS IN OUR AREA

Aquatic insects

Badger

Birds

Bobcat

Coyote

Lizard

Mole

Mouse

Pocket gopher

Raccoon

Tree frog

Wood rat

Anna's hummingbird

California gnatcatcher

Cooper's hawk

Eagle

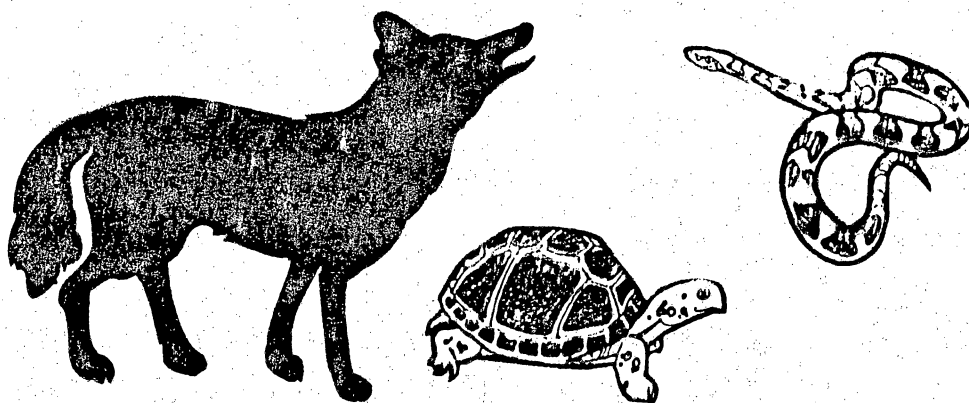
Least Bell's vireo

Lesser goldfinch

Nuttall's woodpecker

Red-tailed hawk

Willow flycatcher



STORM WATER QUESTIONS

Storm water can flow uphill.

FALSE. Water flows downhill because of gravity.

A harmful material is called a pollutant.

TRUE

Storm drains were built to bring water to cities.

FALSE. They were built to prevent flooding by carrying away excess water.

Fertilizers and pesticides pollute water.

TRUE

Soil that has been moved in runoff and left as a deposit is called sediment.

TRUE

Storm water is cleaned by treatment plants before going into waterways.

FALSE. Storm water flows directly into waterways without any treatment.

Leaves and grass clippings should be dumped into storm drains.

FALSE. Grass clippings can be left on the lawn and leaves can be composted.

An arroyo is one example of a waterway.

TRUE

Wildlife is not affected by polluted storm water.

FALSE. Wildlife can live in or near non-treated storm water - so it needs to be clean.

Aquifers hold surface water.

FALSE. Aquifers hold water in storage underground.

Water that is on the surface is called groundwater.

FALSE. It is called surface water.

Rivers and lakes are examples of surface water.

TRUE

Deep holes dug to bring water to the surface are called wells.

TRUE

Wildlife does not live near waterways.

FALSE. Many animals live in or near waterways.

Storm water pollution may affect the water we drink.

TRUE

Everyone lives in a watershed.

TRUE

Animal droppings do not cause storm water pollution.

FALSE. Droppings could get washed into storm water and contaminate it.

“Habitat” is another word for an animal’s home.

TRUE

The water level in a well will drop when more water flows into a nearby lake.

FALSE. It will probably rise.

Pumps are used to force water up through wells.

TRUE

The source of storm water pollution is easy to find and easy to clean up.

FALSE. It is difficult and costly to locate and clean up.

Aquifers contain large layers of sand and gravel.

TRUE

All the water that drains into a single waterway is called a watershed.

TRUE

Wells are used to obtain surface water.

FALSE. Wells are used to obtain groundwater.

Storm water pollution can occur on parking lots and streets.

TRUE

Healthy fish do not need clean surface water.

FALSE. Fish need clean water to live and grow.

Off-road vehicles do not cause storm water pollution.

FALSE. Off-road vehicles which are driven off trails can cause erosion which can pollute water.

Flowing water can carry objects such as trash and pet droppings into drains.

TRUE

Illegal dumping is okay as long as it occurs far from houses.

FALSE. Pollution from dumping still affects drinking water, wildlife, and plants.

Erosion is an indicator (clue) of runoff.

TRUE

Spilled oil, gas, and grease should be washed down the driveway into the street.

FALSE. Oil, gas, and grease should be put into containers and taken to a recycling center which recycles them or disposes of them properly.

Storm drains begin at the inlets and carry water directly to waterways.

TRUE

Driveways should be washed down with soap and water.

FALSE. They should be swept with a broom.

Rock and debris pollute storm water.

TRUE

“Water-based” paints should be cleaned in the driveway, not the sink.

FALSE. They should be cleaned in the sink. Washing them in the driveway will pollute storm water.

The Pacific Ocean and reservoirs are bodies of water.

TRUE

Plants such as groundcovers do not control erosion.

FALSE. Plants hold the soil in place which prevents erosion (a cause of the pollutant “sediment”).

The ocean is an example of surface water.

TRUE

Pet droppings near a waterway should not be removed.

FALSE. They should be picked up so they do not wash into the waterway.

Pets can pollute the water.

TRUE

Storm water pollution comes only from the cities - not farms.

FALSE. Pollution, in the form of fertilizers, pesticides, and yard wastes, comes from both cities and farms.

Pollution can seep underground and contaminate groundwater.

TRUE

Streams and rivers empty into storm drains.

FALSE. Storm drains empty into streams and rivers.

A down spout carries water from the rain gutters on a building to the ground.

TRUE

Litter is not a cause of storm water pollution.

FALSE. Litter can be washed into drains and waterways, causing pollution.

A storm drain is another word for sewer pipe.

FALSE. Sewer water goes to treatment plants for cleaning but storm water goes directly into waterways without any cleaning.

The water we drink comes from both groundwater and surface water.

TRUE

Erosion causes storm water pollution.

TRUE

All rainwater soaks directly into the ground.

FALSE. Some rain- water also flows over the surface of the ground as runoff.

A creek is larger than a river.

FALSE. A creek is smaller than a river.

Pollutants from the air could pollute storm water.

TRUE

The sand and gravel particles in an aquifer do not allow water to soak through.

FALSE. There are spaces between the sand and gravel particles which allow water to flow through.

GLOSSARY

(adapted from definitions in Project WILD, Project WILD Aquatic,
and the Thorndike and Barnhart Dictionary)

aquifer: a slowly renewed underground reservoir.

arroyo: a small river; gully; the dry bed of a stream.

bay: part of a sea or lake extending into the land.

channel: a body of water connecting two larger bodies of water.

debris: rubbish; scattered fragments.

down spout: a pipe carrying water from the rain gutter on a building down to the ground.

erosion: the natural wearing away of the land surface by wind or water. Human practices often intensify erosion.

groundwater: water that infiltrates into the soil and is stored in slowly renewed underground reservoirs called aquifers.

habitat: a plant or animal's home; the arrangement of food, water, shelter, or cover, and space suitable to an organism's needs.

inlet: an opening in the street curb allowing runoff into the storm drain.

litter: scattered rubbish

non-toxic: a substance that is not poisonous.

pesticide: an agent used to control undesirable organisms. This can be an insecticide for insect control, an herbicide for weed control, a fungicide for control of fungal plant diseases, or a rodenticide for killing rats and mice.

pollutant: a harmful material causing pollution.

pollution: harmful substances deposited in air, water, or on land, leading to a state of dirtiness, impurity, unhealthiness, or hazard.

rain gutter: the open pipe which collects rain water from the roof of a building and then drains into a down spout.

reservoir: a place in which water is stored.

runoff: water that drains or flows off the surface of the land.

saturated: soak thoroughly; fill full.

sediment: soil that has been moved in runoff and left as a deposit in waterways; includes particles of soils, sand, silt, clay, and minerals.

storm drain: an underground pipeline that carries water from the inlet to a waterway.

storm water: water which has fallen as rain; snow or hail which melts into water

surface water: water on the surface of the Earth.

toxic: poisonous.

watershed: all the water that drains into a single waterway.

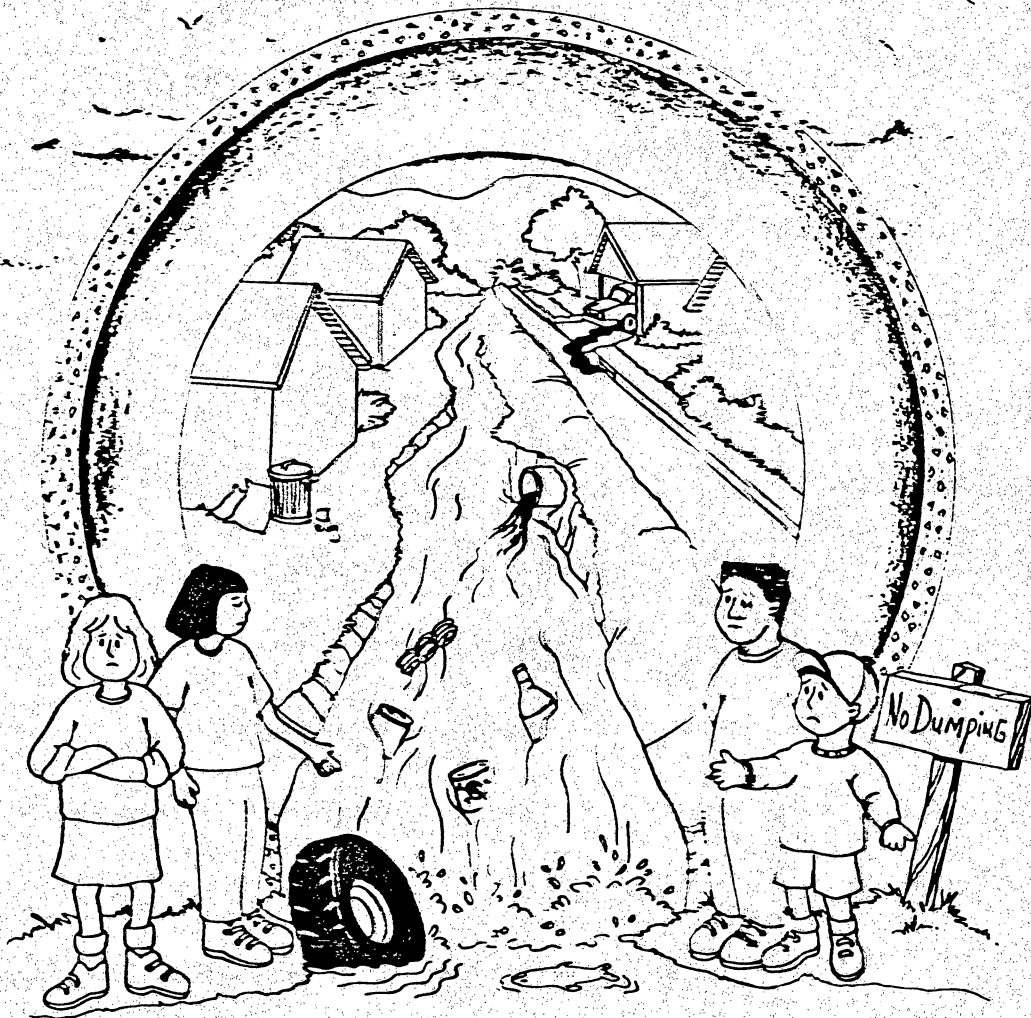
waterway: a path of water such as a river or a stream. Also called a channel.

well: a deep hole dug into the ground from which water can be brought to the surface.

wildlife: animals that are not tamed or domesticated. Wildlife includes, but is not limited to, insects, spiders, birds, reptiles, fish, amphibians, and mammals, if non-domesticated.

APPENDIX B
STUDENT BOOKLET

Storm Water Pollution Patrol

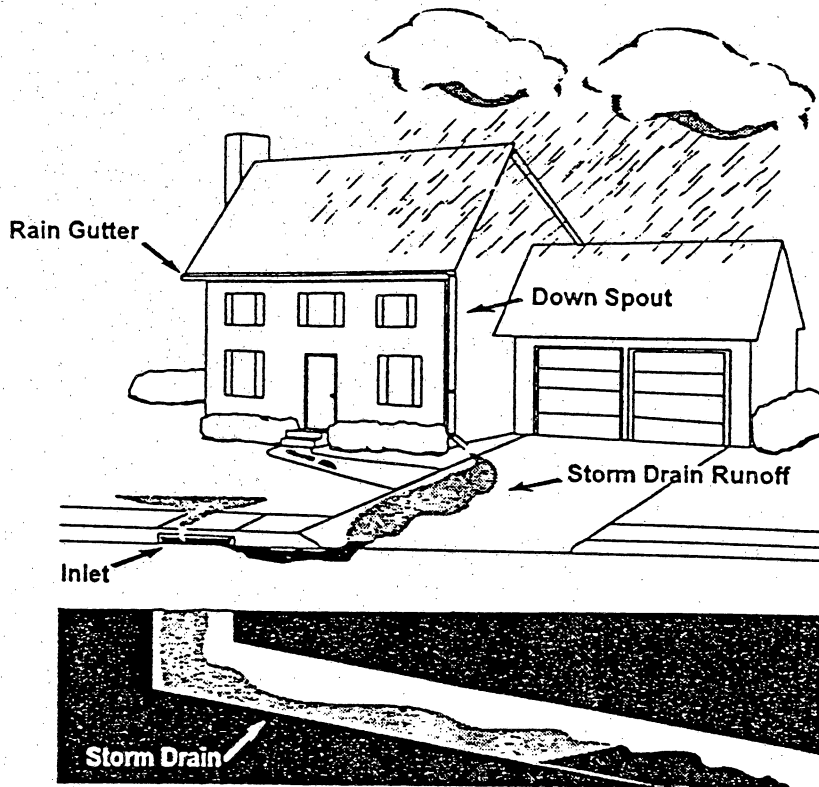


To receive your Storm Water Pollution Patrol Award, complete the activities in this booklet along with other activities chosen from the Storm Water Pollution Patrol Award application form.

Pollution Patrol Activities by _____ Your Name _____



What is Storm Water?



When it rains, some of the rain water soaks into the ground and some of it flows over the ground. The rain that runs over streets, fields, yards and roofs is called **storm water runoff**. Storm water runoff flows downhill through low lying areas.

In cities, runoff collects along street curbs and flows into openings or inlets. From the inlets, the water drops into underground pipelines called **storm drains**. Storm drains carry runoff directly to **waterways** or **channels** such as streams and rivers.

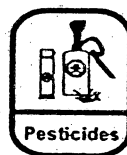
Storm drains are designed to prevent flooding by carrying away excess water. The problem is, they capture pollutants as well.

Pollution is a Problem!



When rain water flows over surfaces like roofs and streets it collects other materials. For example, when rain water flows over spilled motor oil in driveways or parking lots it carries oil and other pollutants along with the runoff water. As rain gathers into larger flows it can pick up and move heavier objects such as trash, yard cuttings and pet wastes.

Storm water becomes polluted when it mixes with harmful materials. Many products that we use in and around our homes actually pollute storm water. Here are examples of some things that do not belong in water:



♦Activity 1

Make a neighborhood survey of storm drains and pollutants:

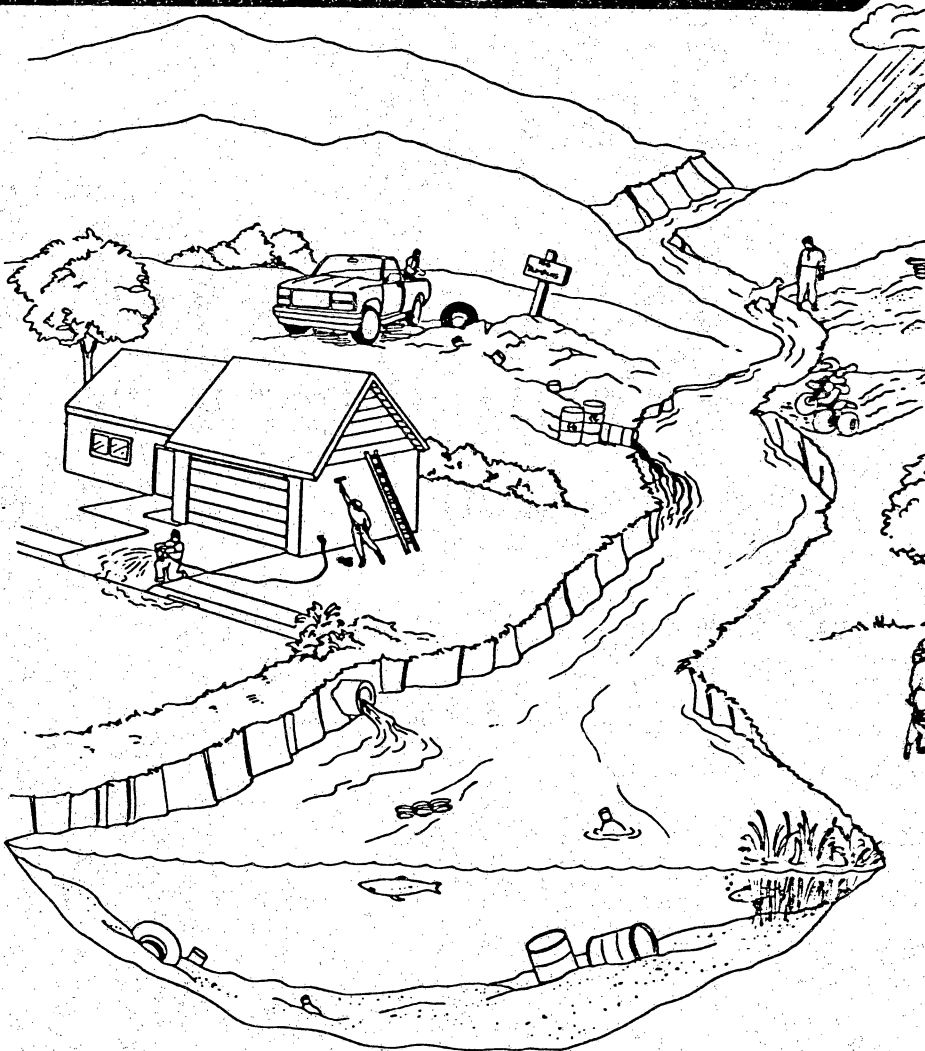
Look around your neighborhood for storm drains and for the direction that water flows. Remember that water only flows downhill. Are there signs of pollutants that could wash into the storm drains? Look for deposited materials such as trash, debris and sediment. Sediment is soil that has been moved in runoff and left as a deposit along the road. Collect any likely pollutants that could wash into storm drains or waterways. Dispose of them properly.

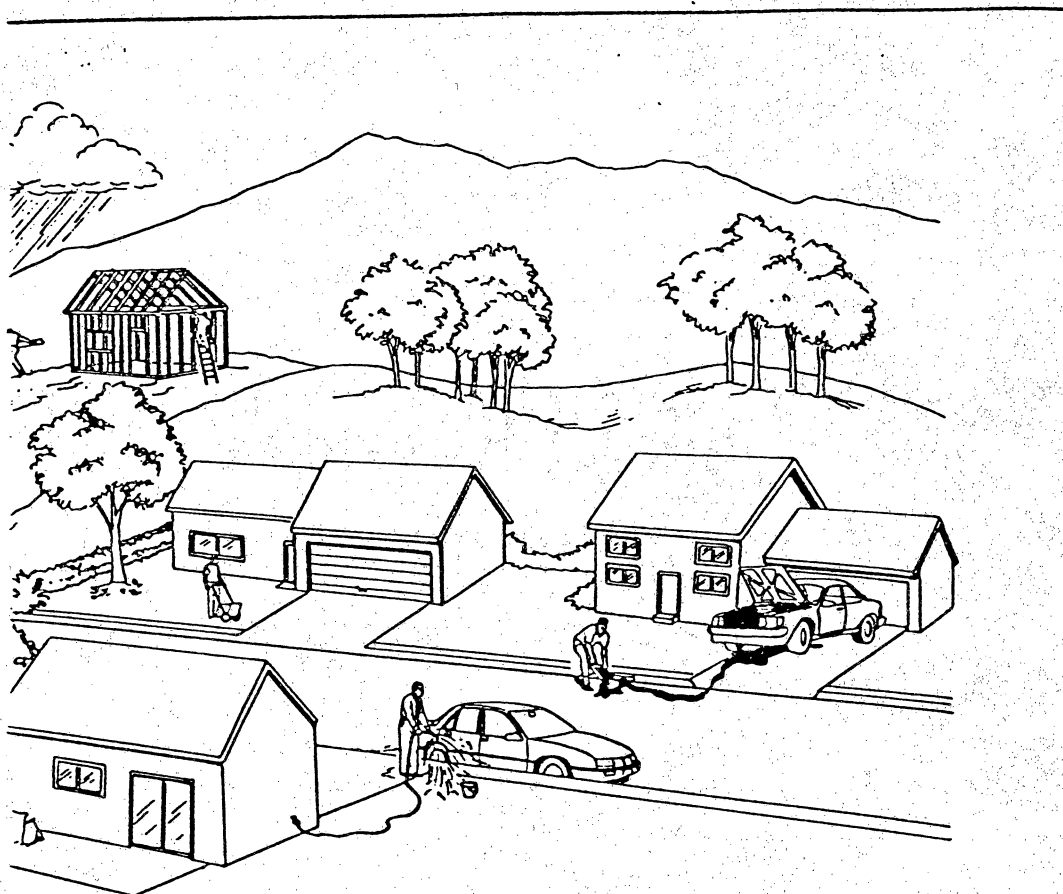
Record the pollutants that you find below:

Pollutant	Where could it have come from?	How could it have been prevented?



Pollution Comes From Different Places





Storm water pollution occurs wherever rain water flows over streets, roofs, yards, parking lots, building sites, forests, and farms. Water runoff from the daily use of garden hoses and sprinklers can also carry pollutants into the storm drain.

Different kinds of pollutants come from different places. For example, leaked motor oil comes from paved areas where cars drive, such as streets and parking lots. Pesticides (bug killers) come from farms and yards that have been sprayed to control pests.

Storm water pollution also happens when people dump pollutants into storm drains and waterways. Some people assume that storm drains are sewers for disposing of waste, like the drains in our homes. However, storm drains flow directly to water and wildlife areas. Storm water is not cleaned before reaching our rivers, lakes and oceans.

♦Activity 2

Circle the many sources of storm water pollution that you find in these pictures.



Where Does the Storm Water Go?

Storm waters flow downhill to nearby waterways. A waterway has many names: channel, creek, brook, stream, arroyo, wash and river. Smaller waterways, such as creeks, usually join into larger ones, such as rivers, as waters continue to merge on their way downhill.

Waterways carry runoff to bodies of water such as lakes, reservoirs, bays, and the ocean.

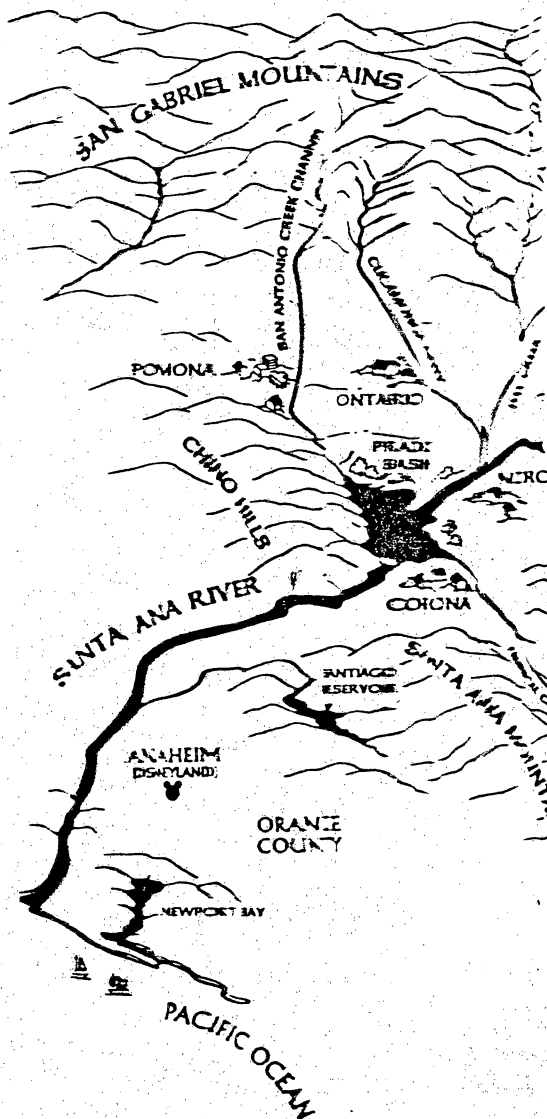
The watershed drawing to the right shows where water flows in our area. All the land that drains into a single waterway is called a watershed.

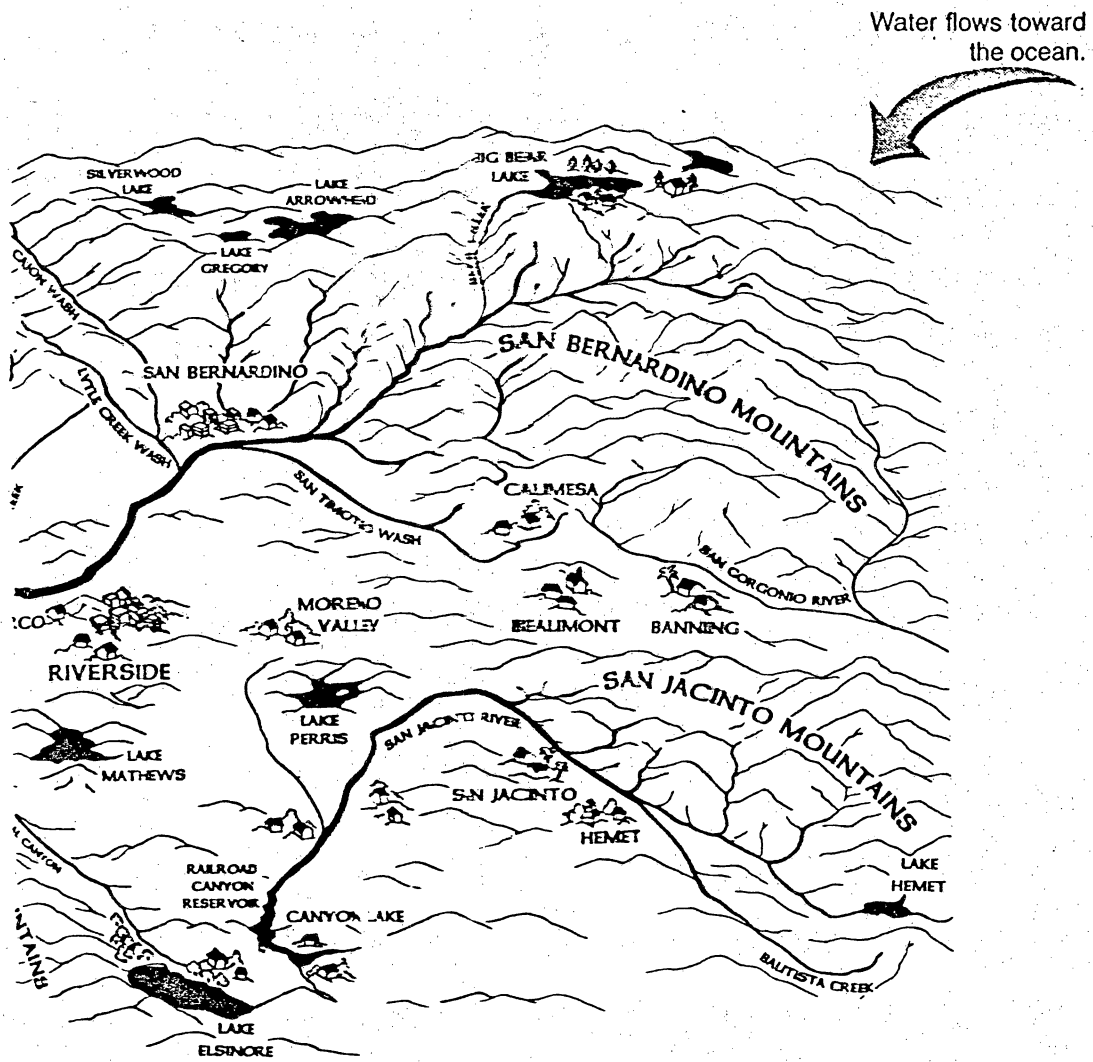
♦Activity 3

Find your waterway and watershed:

- ♦ On the watershed drawing, find the place where you live.
- ♦ Find the nearest waterway. Trace along the waterway with blue. The slope of the land determines which watershed you live in and which waterway drains the land you live on.
- ♦ Follow the blue colored waterway downstream (downhill) until it runs into another waterway or body of water. Water runs downhill from the mountains to the ocean.

Remember, your actions can pollute or protect the entire route you have traced.





♦Activity 4

What are the names of the bodies of water that you can help keep clean by preventing storm water pollution?

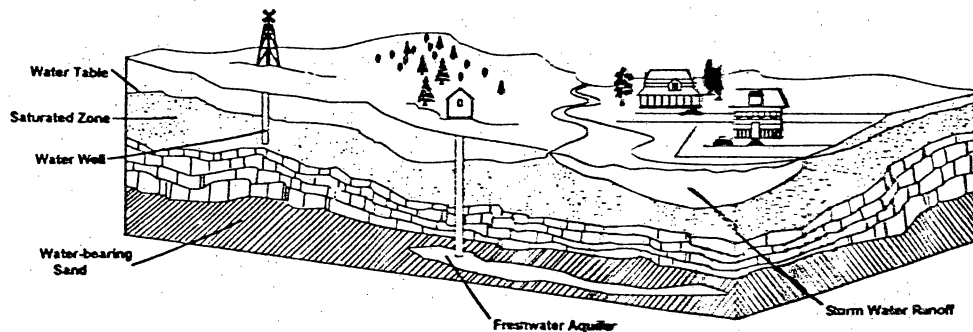
Find them on the watershed drawing and list them below:



What Happens to Storm Water that Soaks into the Ground?

Water that soaks through the soil seeps into the underground areas called **aquifers**. Aquifers are large layers of sand and gravel. Water fills the spaces between the sand and gravel particles. Aquifers hold water in storage underground. Water that is buried underground is called **groundwater**.

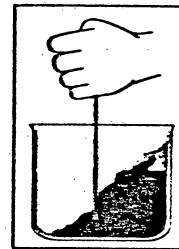
In Riverside County, we use water from aquifers every day. To bring water to the surface, we dig deep holes called **wells**. Pumps force water up through wells. In places with no wells, water can stay underground for thousands of years.



♦Activity 5

Make a model of storm water pollution:

- ♦ In a clear container, form a "hillside" by pressing sand into a 45 degree angle.
- ♦ Add water to the container forming a "lake," without disturbing the sand. *Does the water seep into the sand to form "groundwater?"*
- ♦ Insert a clear straw through the sand to represent a well. *What happens to the water level in the well when you add water to the lake?*
- ♦ Sprinkle powdered red food coloring or red Koolaid on the sand. The powder represents pollution.
- ♦ Spray or dribble water over the powder for rain. *Where does the "pollution" spread? What happens to the water? What happens to the sand?*

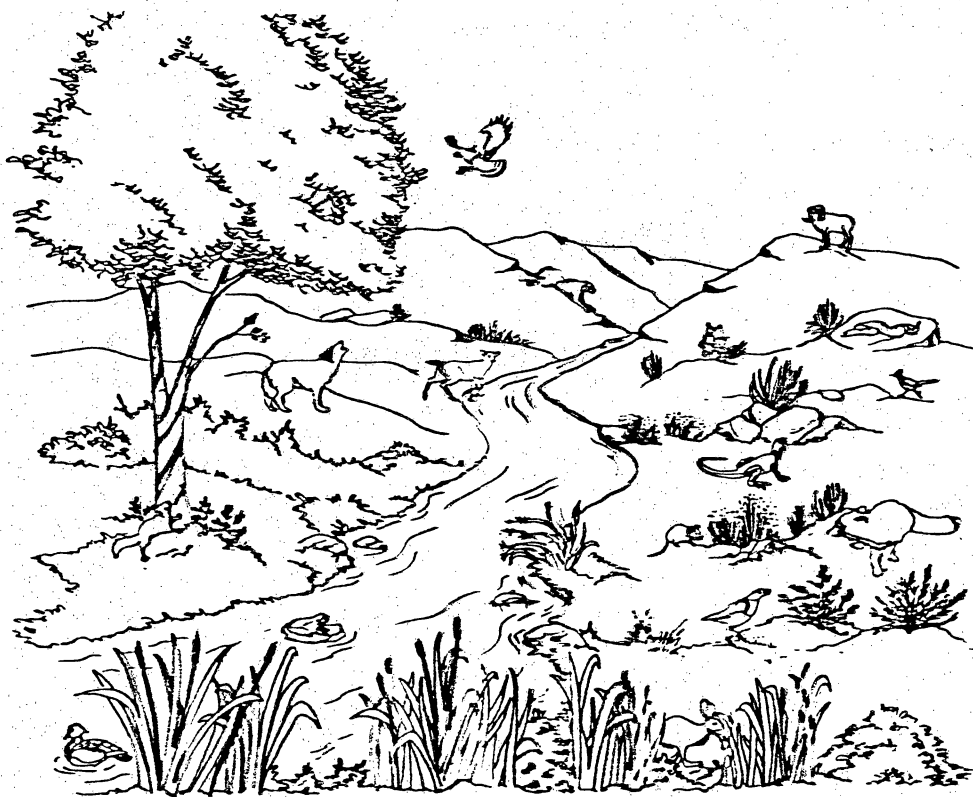




Why is Storm Water Pollution a Problem?

Polluted water is unhealthy and unsafe for living things. People, plants and animals all need clean water. Pollution makes water unsafe for swimming, boating and fishing.

The water we drink comes from groundwater as well as surface water. If pollution seeps underground, our water will no longer be safe or healthy.



♦Activity 6

When surface water is polluted, it harms the creatures that live in the water as well as the wildlife that lives near it. Waterways provide homes or habitat for plants, fish, birds, and many different animals. **Which animals and plants can you identify?**

E

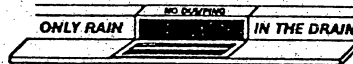
You Can Help to Protect Our Water



*Check the ways you plan to
prevent Storm Water Pollution*

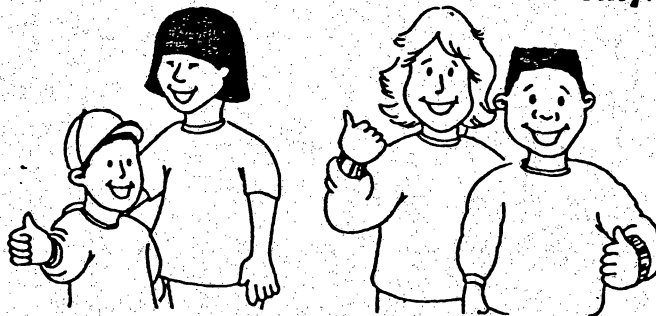
- ☐ Keep litter, pet wastes, leaves and debris out of street gutters and storm drains.
- ☐ Dispose of waste in its proper place:
 - ◆ Put litter in a trash can;
 - ◆ Place leaves and yard clippings in a compost pile;
 - ◆ Encourage your family to take automotive fluids, tires and batteries to car repair businesses for recycling;
 - ◆ Recycle and reuse whenever you can;
 - ◆ Encourage your family to take hazardous waste to Community Collection Events. Your parents can call (909)358-5256 for information.
- ☐ Report illegal dumping. Ask your parents to call the police, sheriff, or 1-800-506-2555 as soon as possible.
- ☐ Clean up spilled brake fluid, oil, antifreeze and grease. Don't hose them off driveways into the street. Sweep driveways instead of washing them down with soaps and solvents. Wash cars on the lawn with non-toxic soap.
- ☐ Help keep cars in good running condition to reduce leaks and air pollution. Rain also washes air pollution into storm drains.
- ☐ Clean *water-based* paints in the sink, not in the driveway or gutter.

- ☐ Use non-toxic household products whenever possible. Read labels and learn which household items are hazardous. Encourage your family to buy products labeled "non-toxic."
- ☐ If you ride off-road vehicles, avoid eroding hillsides and protect plants that hold soil in its place.
- ☐ Water and take care of groundcovers, trees, and shrubs. By growing plants on sloping land, you will keep soil from washing into streets and storm drains.
- ☐ Divert roof downspouts to drain onto the lawn. That way, runoff will help water the lawn and be filtered by the grass.
- ☐ Don't overdose the environment! Encourage adults to follow the directions when applying pesticides and fertilizers.
- ☐ Help paint storm drains to remind people that storm drains are designed for storm water only.
- ☐ Share your knowledge with others. Tell your friends and family how they can help keep our water clean.

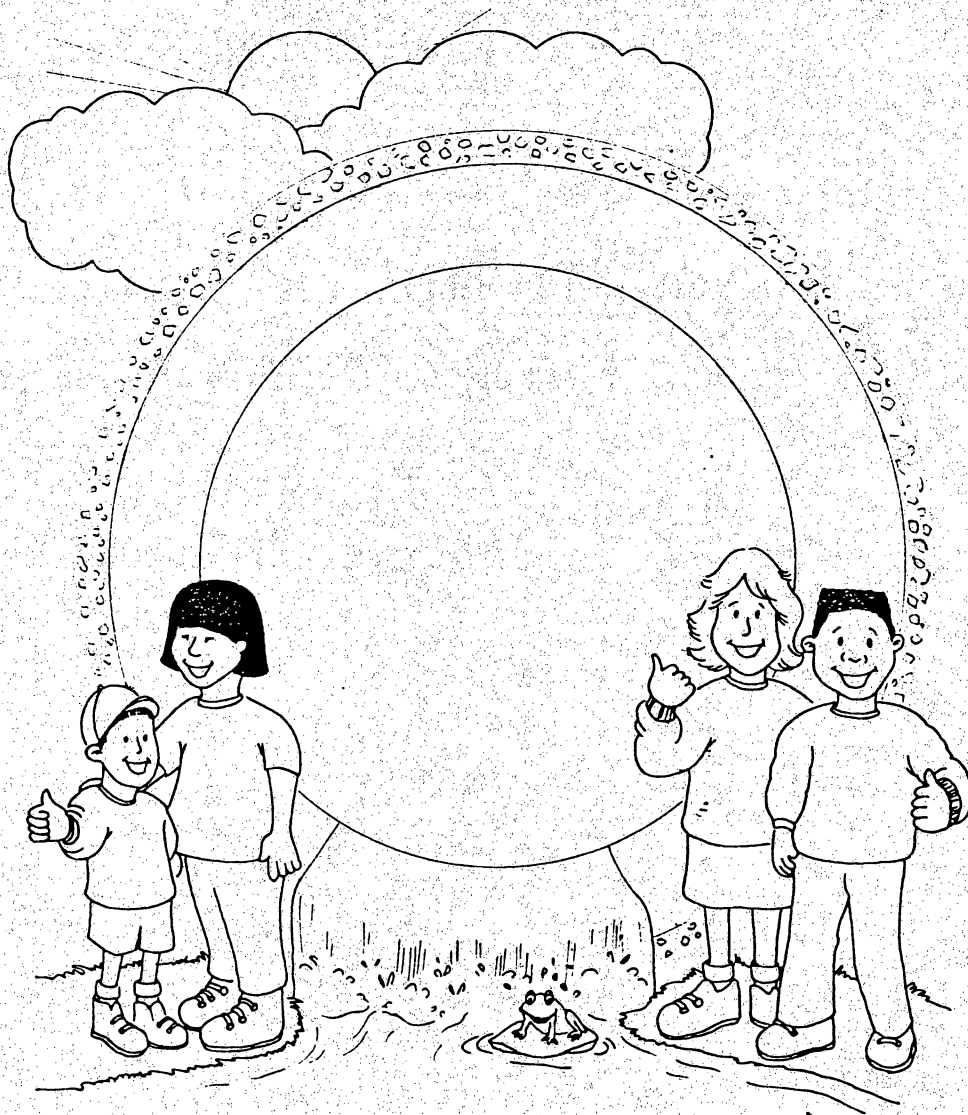


Remember

Storm Water should be Clean Water only!



Help Keep Our Water Clean!



**Compare this picture to the front cover and
draw a picture of a scene *without* storm water pollution.**

Sponsored by the Cities and County of Riverside's StormWater CleanWater Protection Program. Produced in cooperation with the Riverside-Corona Resource Conservation District. School distribution provided by the Riverside County Office of Education. For information call the StormWater Education Coordinator at (909) 275-1111.

Storm Water
Clean Water
PROTECTION PROGRAM

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